MCS-40™ PROTOTYPE SYSTEM

MCS-40 SYSTEM — INTEL'S LOWEST COST MICROCOMPUTER. IDEAL FOR PROTOTYPE OR LOW VOLUME PRODUCTION AND RANDOM LOGIC REPLACEMENT.

The MCS-40 Microcomputer gives the user the design and computational capability of larger and more complex computers with just a small assortment of easy to use components. The set of parts are designed to offer the user an economical alternative to random logic.

The basic kit consists of the following standard building blocks:

- 4040 CPU
- 4269 Programmable Keyboard/ Display Device
- 4265 Programmable General Purpose I/O
- 2111A 256 x 4 Static RAM
- 4289 Standard Memory Interface with I/O
- 4702A Programmable ROM
- 4201A System Clock

Due to the high degree of modularity of the MCS-40 system, additional components can be added to the kit to optimize it for the user's unique application. All components are fabricated with silicon gate, low threshold, PMOS technology.

The MCS-40 systems interface easily with switches, keyboards, displays, printers, communication terminals, and other popular peripherals. The 4269 Programmable Keyboard/Display greatly facilitates keyboard and display interfaces because of its automatic hardware support of functions such as keyboard scan and display refresh. The 4265 Programmable General Purpose I/O device allows easy interfacing to synchronous and asynchronous I/O devices, 8-bit peripheral devices, 8-bit microcomputers and standard memory devices such as the 2111A RAM.

A system built with the MCS-40 microcomputer set can have up to 8K x 8 of program memory in ROM or PROM, 1280 x 4-bit of RAM data memory and over 128 I/O lines, without requiring any interface logic. Further expansion of this very powerful system is accomplished with the addition of a few simple gates.

The MCS-40 Microcomputer has a very extensive instruction set which designers find extremely easy to use. The instruction set includes 60 powerful instructions, including true interrupt and a single step mode of operation. The basic instruction set consists of:

- Binary and Decimal Arithmetic
- Logical AND and OR
- Add and Subtract from Memory
- Rotate, Complement, and Test Accumulator
- Increment Registers
- Exchange Registers with Accumulator
- Conditional and Unconditional Branches and Subroutine Calls
- Increment, Test, and Branch in Single Instructions
- I/O Instructions
- Special Keyboard Instruction
- Interrupt Enable/Disable
- ROM and Register Bank Switching

In addition to the large assortment of MCS-40 components, Intel offers a complete line of resident and cross software products, hardware development aids such as the Intellec® 4/MOD 40 development system, user field training courses and an extensive staff of field application engineers to assist you with your unique design.

Programmable General Purpose Microcomputer

Program Storage in 4702A Reprogrammable PROM Simulates ROM

Instructions (60 total) including Logical Operations and Read Program Memory

Large Number of Family Devices

10.8 Microsecond Instruction Cycle Standard

Interrupt Capability

Single Step Operation

8K Byte Memory Addressing Capability

24 Index Registers

Subroutine Nesting to 7 Levels

2-Phase Dynamic Operation

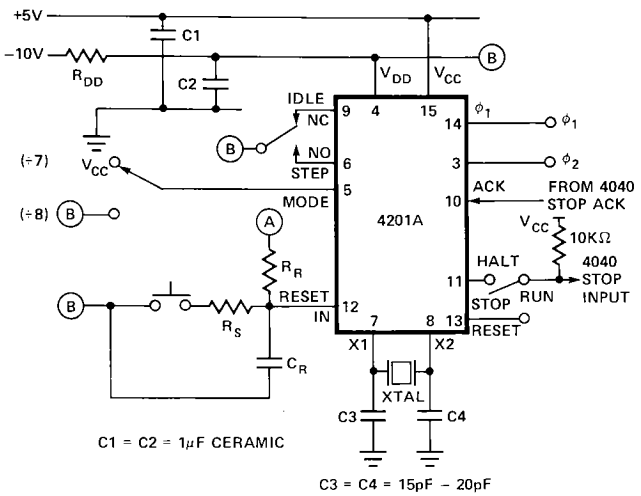
Instruction Set Includes Conditional Branching, Jump to Subroutine and Indirect Fetching

Logical Instructions

Binary and Decimal Arithmetic Modes

Unlimited Number of Input and Output Lines

4201A Implementation



Design Considerations

CRYSTALS

Either ÷7 or ÷8 Modes may be used. Mode equals V_{CC} for ÷7, Mode equals V_{DD} for ÷8. The clock frequency range should be between 500 kHz (4 MHz XTAL, ÷8 MODE) and 740 kHz (5.185 MHz XTAL, ÷7 MODE). The crystal may be found as a standard product from Intel distributors, CTS Knights or Crystek.

X1 AND X2 INPUT CAPACITANCE

The XTAL terminals, X1 and X2, should be tied to 15 pF - 20 pF capacitors C3 and C4 to AC system GND.

POWER SUPPLY VOLTAGE CONSIDERATIONS

1. Operation is guaranteed with V_{CC}-V_{DD} = 15V ± 5%. During system power-up or during power supply glitching, the maximum magnitude of (V_{CC}-V_{DD}) must be limited to 17 volts.

   During the power supply rise time (that is, when $|V_{CC}-V_{DD}| < 14.25$ volts), improper ϕ_1, and ϕ_2 output may occur until $|V_{CC}-V_{DD}|$ reaches the 14.25 minimum voltage.

2. With V_{CC} = +5V, V_{DD} = -10V, bypass capacitor C1 of 1 μF and C2 and 1 μF in parallel from V_{CC} to GND and V_{DD} to GND, respectively, should provide excellent bypassing. Bypass capacitors should be ceramic or equivalent quality to insure low inductance and low series resistance.

3. The purpose of the current limiting register R_{DD} is both to limit ϕ_1 and ϕ_2 rise times and to drop V_{DD} at the 4201A V_{DD} pin. Values for R_{DD} as a function of ϕ_1, ϕ_2 load capacitance are:
   For $C_{LOAD} < 50$ pF; use $R_{DD} = 100\Omega$.
   For 50 pF $< C_{LOAD} <$ 100 pF; use $R_{DD} = 68\Omega$.
   For 100 pF $< C_{LOAD} <$ 300 pF; use $R_{DD} = 27\Omega$.
   For $C_{LOAD} > 300$ pF; use $R_{DD} = 10\Omega$.

   All 4201A functions requiring the V_{DD} voltage should use the pin V_{DD} or node (B) on the 4201A side of resistor R_{DD}. Operation with the voltage drop across R_{DD} is guaranteed by Intel testing.

4. Single-Supply System (+15 V or -15)

   Recommended 4201A circuit modifications for single supply systems are:

   1. The 1 μF ceramic capacitor C1 should be between 4201A V_{DD} and V_{CC} pins.
   2. Other capacitors shown as being grounded should be connected to V_{CC}.
   3. Reset R_R is connected to V_{CC}. Reset C_R is connected to V_{DD} pin.
   4. The current limiting resistor R_{DD} is still needed. in the V_{DD} line.

5. Power Supply Rise Times

   Intel testing is for power supply rise times between 5 ms and 300 ms. For power supply rise times less than 5 ms, a 200KΩ resistor from X1 to GND and C3 = C4 = 5 pF is recommended.

RESET NETWORK

The Reset input has $V_{IL} = V_{CC}-11$ volts and $V_{IH} = V_{CC}-6.5$ volts, with about 1 volt of hysteresis (Schmitt circuit).

Node (A) must be tied to GND or V_{CC} = +5 V; and R_R and C_R selected, such that the negative V_{DD} transition moves the Reset input below V_{IL}.

Tying node (A) to GND and making C_R very large, i.e. >1μF, will allow the greatest freedom in V_{CC} and V_{DD} rise times during turn-on. Tying node (A) to GND will also cause Reset after a V_{DD} glitch to GND.

The purpose of R_S at 510Ω or 1KΩ is to limit Reset input fall time on manual Reset, so that the Reset input does not fall below V_{DD}.

TTL CLOCK OUTPUTS

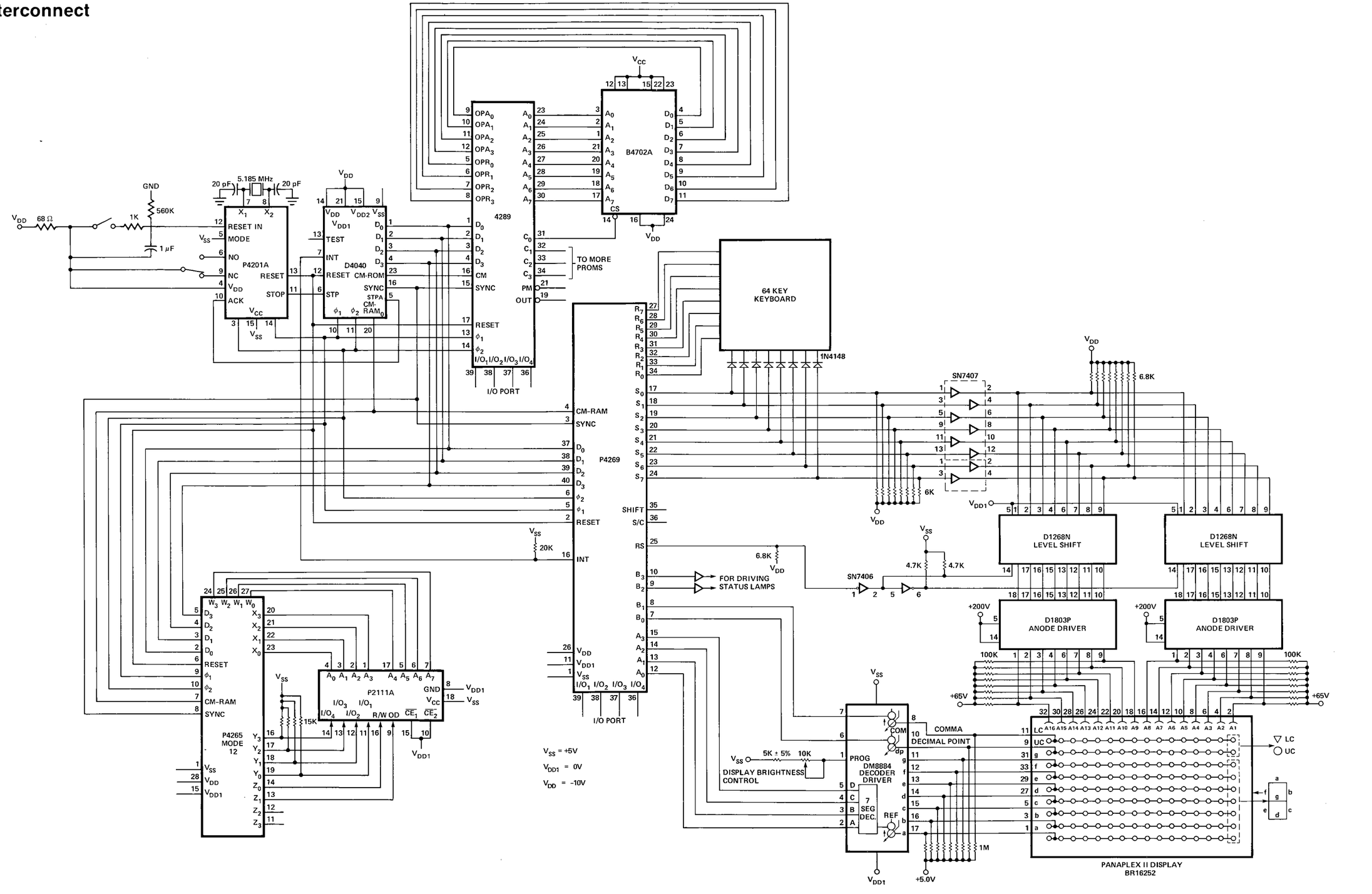
If ϕ_{1T} and ϕ_{2T} are used, GND pin should be tied to logic ground. ϕ_{2T} levels will swing between V_{CC} and GND.

UNUSED FUNCTIONS

If any of the 4201A functions listed below are not used, for power conservation it is recommended that the pins be connected as described below:

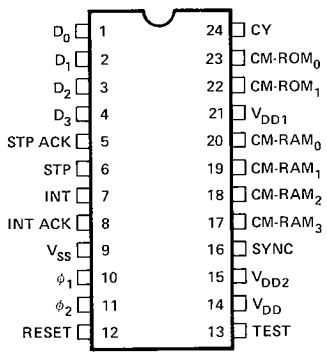
1. ϕ_{1T},ϕ_{2T}
   Tie GND pin, ϕ_{1T}, ϕ_{2T} to V_{CC}.
2. Single step
   Tie NO to V_{CC}.
   Tie NC to Node (B) (V_{DD} pin).
   Tie STOP ACK to V_{CC}.
   STOP left open.
3. Reset
   Tie RESET IN, RESET OUT to V_{CC}.

System Interconnect

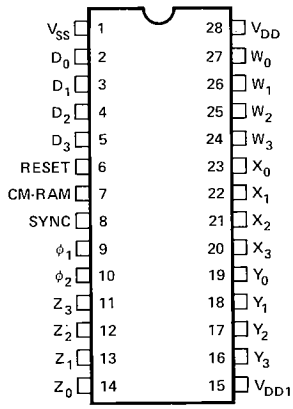


Pin Configurations

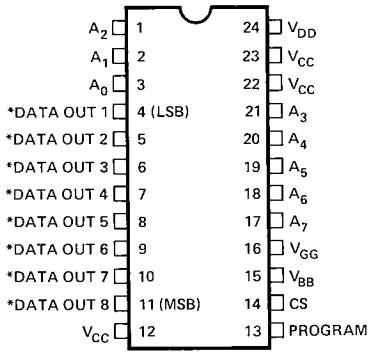
4040 CPU



4265 GP I/O

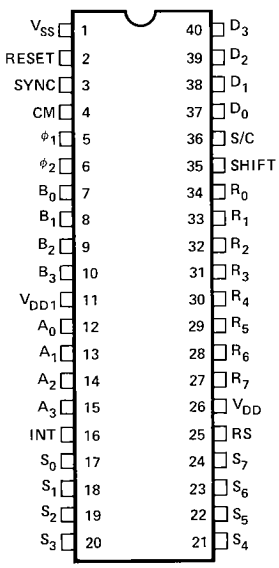


4702A ROM

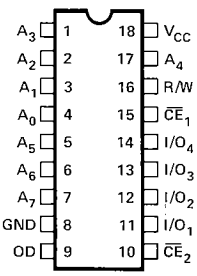


*THIS PIN IS THE DATA INPUT LEAD DURING PROGRAMMING

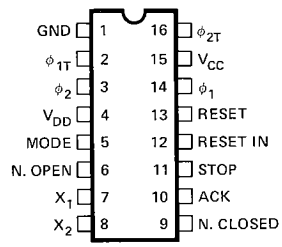
4269
KEYBOARD/DISPLAY



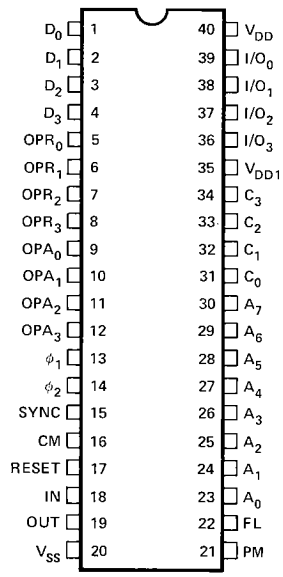
2111A RAM



4201A CLOCK
GENERATOR



4289 INTERFACE



3065 Bowers Avenue
Santa Clara, California 95051
Tel: (408) 246-7501
TWX: 910-338-0026
TELEX: 34-6372

SALES AND MARKETING OFFICES

U.S. AND CANADIAN SALES OFFICES

ALABAMA
Glen White Associates
7844 Horseshoe Trail
Huntsville 35802
Tel: (205) 883-9394

ARIZONA
Sales Engineering, Inc.
7155 E. Thomas Road, No. 6
Scottsdale 85252
Tel: (602) 945-5781
TWX: 910-950-1288

CALIFORNIA
Intel Corp.*
990 E. Arques Ave.
Suite 112
Sunnyvale 94086
Tel: (408) 738-3870
TWX: 910-339-9279
TWX: 910-338-0255

Mac-I
P.O. Box 1420
Cupertino 95014
Tel: (408) 257-9880

Earle Associates, Inc.
4433 Convoy Street
Suite A
San Diego 92111
Tel: (714) 278-5441
TWX: 910-335-1585

Intel Corp.*
1651 East 4th Street
Suite 228
Santa Ana 92701
Tel: (714) 835-9642
TWX: 910-595-1114

COLORADO
Intel Corp.
12075 East 45th Avenue
Suite 310
Denver 80239
Tel: (303) 373-4920
TWX: 910-932-0322

CONNECTICUT
Intel Corp.
8 Mill Plain Road
Danbury 06810
Tel: (203) 792-8366

FLORIDA
Intel Corp.
2020 W. McNab Road, Suite 104
Ft. Lauderdale 33309
Tel: (305) 971-7200
TWX: 510-956-9407

Intel Corp.
5151 Adanson Street, Suite 200-3
Orlando 32804
Tel: (305) 628-2393
TWX: 810-853-9219

ILLINOIS
Intel Corp.*
1000 Jorie Boulevard
Suite 224
Oakbrook 60521
Tel: (312) 325-9510
TWX: 910-651-5881

IOWA
Technical Representatives, Inc.
1703 Hillside Drive N/W
Cedar Rapids
Tel: (319) 396-5662

KANSAS
Technical Representatives, Inc.
801 Clairborne
Olathe 66061
Tel (913) 782-1177
TWX: 910-749-6412

MARYLAND
Glen White Associates
57 West Timonium Road
Timonium 21093
Tel: (301) 252-7742

Intel Corp.*
57 West Timonium Road
Suite 307
Timonium 21093
Tel: (301) 252-7742
TWX: 710-232-1807

MASSACHUSETTS
Intel Corp.*
187 Billerica Road, Suite 14A
Chelmsford 01824
Tel: (617) 861-1136
TWX: 710-343-6333

MICHIGAN
Intel Corp.
725 South Adams Road
Suite 288
Birmingham 48011
Tel: (313) 642-7018
TWX: 910-420-1212
TELEX: 2 31143

MINNESOTA
Intel Corp.
675 Southgate Office Plaza
5001 West 80th Street
Bloomington 55437
Tel: (612) 835-6722
TWX: 910-576-2867

MISSOURI
Technical Representatives, Inc.
Trade Center Bldg.
300 Brookes Drive, Suite 108
Hazelwood 63042
Tel: (314) 731-5200
TWX: 910-762-0618

NEW JERSEY
Intel Corp.
2 Kilmer Road
Edison 08817
Tel: (201) 985-9100
TWX: 710-480-6238

NEW YORK
Intel Corp.*
6901 Jericho Turnpike
Syosset 11791
Tel: (516) 364-9860
TWX: 510-221-2198

Intel Corp.
474 Thurston Road
Rochester, N.Y. 14619
Tel: (716) 328-7340
TWX: 510-253-3841

NEW YORK (cont.)
T-Squared
3522 James Street
Syracuse 13206
Tel: (315) 463-8592
TWX: 710 541-0554

T-Squared
640 Craig Road
P.O. Box W
Pittsford 14534
Tel: (716) 381-2551
TELEX: 97-8289

Intel Corp.
55 Market Street
Poughkeepsie, New York 12601
Tel: (914) 473-2303
TWX: 510-248-0060

NORTH CAROLINA
Glen White Associates
913 Plateau Lane
Raleigh 27609
Tel: (919) 876-5617

OHIO
Intel Corp.*
8312 North Main Street
Dayton 45415
Tel: (513) 890-5350
TELEX: 288-004

Intel Corp.*
26250 Euclid Ave.
Suite 531F
Euclid 44132
Tel: (216) 289-0101

PENNSYLVANIA
Intel Corp.*
520 Pennsylvania Ave.
Fort Washington 19034
Tel: (215) 542-9444
TWX: 510-661-0709

TENNESSEE
Glen White Associates
206 Chickasaw Drive
Johnson City 37601
Tel: (615) 928-0184

TEXAS
Evans & McDowell Associates
13777 N. Central Expressway
Suite 405
Dallas 75231
Tel: (214) 238-7157
TWX: 910-867-4763

Evans & McDowell Associates
6610 Harwin Avenue, Suite 125
Houston 77036
Tel: (713) 783-2900

Intel Corp.*
6350 L.B.J. Freeway
Suite 178
Dallas 75240
Tel: (214) 661-8829
TWX: 910-860-5487

VIRGINIA
Glen White Associates
P.O. Box 1104
Lynchburg 24505
Tel: (804) 846-4624

WASHINGTON
E.S./Chase Co.
P.O. Box 80903
Seattle 98108
Tel: (206) 762-4824
Twx: 910-444-2298

CANADA
Intel Corp.
70 Chamberlain Ave.
Ottawa, Ontario K1S 1V9
Tel: (613) 232-8576
TELEX: 053-4419

Multilek, Inc.
4 Barren Street
Ottawa, Ontario K2J 1G2
Tel: (613) 825-4695
TELEX: 053-4585

EUROPEAN MARKETING OFFICES

BELGIUM
Intel International*
Rue du Moulin à Papier
51-Boite 1
B-1160 Brussels
Tel: (02) 660 30 10
TELEX: 24814

FRANCE
Intel Corporation, S.A.R.L.*
74, Rue D'Arcueil
Silic 223
94528 Rungis Cedex
Tel: (01) 687 22 21
TELEX: 270475

SCANDINAVIA
Intel Scandinavia A/S*
Lyngbyvej 32 2nd Floor
DK-2100 Copenhagen East
Denmark
Tel: (01) 18 20 00
TELEX: 19567

Intel Sweden AB*
Box 86
S-16212 Vällingby 1
Sweden
Tel: (08) 37 53 70
TELEX: 13164 (ABCENT)

ENGLAND
Intel Corporation (U.K.) Ltd.*
Broadfield House
4 Between Towns Road
Cowley, Oxford OX4 3NB
Tel: (0865) 77 14 31
TELEX: 837203

Intel Corporation (U.K.) Ltd.
46-50 Beam Street
Nantwich, Cheshire CW5 5LJ
Tel: (0270) 62 65 60
TELEX: 36620

GERMANY
Intel Semiconductor GmbH*
Seidlstrasse 27
8000 Muenchen 2
Tel: (089) 55 81 41
TELEX: 523 177

Intel Semiconductor GmbH
D-6272 Niedernhausen
Wiesenweg 26
Tel: (06127) 2314
TELEX: 04186183

Intel Semiconductor GmbH
D-7000 Stuttgart 80
Ernsthaldenstrasse 17
Tel: (0711) 7351506
TELEX: 7255346

ORIENT MARKETING OFFICES

JAPAN
Intel Japan Corporation*
Flower Hill-Shinmachi East Bldg.
1-23-9, Shinmachi, Setagaya-ku
Tokyo 154
Tel: (03) 426-9261
TELEX: 781-28426

HONG KONG
Q1 (Far East) Ltd.
Tak Yan Commercial Bldg. 6th floor
30-32 D'Aguilar Street, Central
Hong Kong
Tel: 5-260311
TELEX: 83138 JADE HX

TAIWAN
Taiwan Automation Co.*
6th Floor, 18-1, Lane 14
Chi-Lin Road
Taipei
Tel: (02) 551726-9
TELEX: 11942 TAIAUTO

TAIWAN (cont.)
Asionics-Taiwan, Inc.
205 Pa-Teh Road, Section 4
Taipei
Tel: 75 55 82
TELEX: 22158 Asionics

INTERNATIONAL DISTRIBUTORS

AUSTRALIA
A. J. Ferguson (Adelaide) PTY, Ltd.
44 Prospect Rd.
Prospect 5082
South Australia
Tel: 269-1244
TELEX: 82635

AUSTRIA
Bacher Elektronische Gerate GmbH
Meidlinger Hauptstrasse 78
A 1120 Vienna
Tel: (0222) 83 63 96
TELEX: (01) 1532

BELGIUM
Inelco Belgium S.A.
Avenue Val Duchesse, 3
B-1160 Brussels
Tel: (02) 660 00 12
TELEX: 25441

DENMARK
Scandinavian Semiconductor
Supply A/S
Nannasgade 18
DK-2200 Copenhagen N
Tel: (01) 93 50 90
TELEX: 19037

FINLAND
Oy Fintronic AB
Karjalankatu 2C,
SF 00520
Helsinki 52
Tel: (90) 664 451
TELEX: 12426

FRANCE
Tekelec Airtronic
Cite des Bruyeres
Rue Carle Vernet
92310 Sevres
Tel: (1) 027 75 35
TELEX: 250997

GERMANY
Alfred Neye Enatachnik GmbH
Schillerstrasse 14
D-2085 Quickborn-Hamburg
Tel: (04106) 6121
TELEX: 02-13590

Electronic 2000 Vertriebs GmbH
Neumarketer Strasse 75
D-8000 Muenchen 80
Tel: (089) 434061
TELEX: 484426

Jermyn GmbH
Postfach 1146
D-6277 Kamberg
Tel: (06434) 6005
TELEX: 484426

HONG KONG
ASTEC International
Keystone House, 2nd Floor
Hankow Road, Kowloon
Tel: 3-687760
TELEX: 74899 ASCOM

ISRAEL
Eastronics Ltd.*
11 Rozanis Street
P.O. Box 39300
Tel-Aviv
Tel: 475151
TELEX: 33638

ITALY
Eledra 3S S.P.A.
Viale Elvezia, 18
20154 Milan,
Tel: (02) 3493041
TELEX: 39332

Eledra 3S S.P.A.
Via Giuseppe Valmarana, 63
00139 Rome, Italy
Tel: (06) 81 27 290 - 81 27 324

JAPAN
Pan Electron
No. 1 Higashikata-Machi
Midori-Ku, Yokohama 226
Tel: (045) 471-8811
TELEX: 781-4773

Ryoyo Electric Corp.
Konwa Bldg.
1-12-22, Tsukiji, 1-Chome
Chuo-Ku, Tokyo 104
Tel: (03) 543-7711

NETHERLANDS
Inelco Nederland
AFD Elektronic
Joan Muyskenweg 22
NL-1006 Amsterdam
Tel: (020) 934824
TELEX: 14622

NORWAY
Nordisk Elektronik (Norge) A/S
Mustads Vei 1
N-Oslo 2
Tel: (02) 55 38 93
TELEX: 16963

SOUTH AFRICA
Electronic Building Elements
P.O. Box 4609
Pretoria
Tel: 78 92 21
TELEX: 30181

SPAIN
Interface
Ronda San Pedro 22
Barcelona 10
Tel: 301 78 51

SWEDEN
Nordisk Electronik AB
Fack
S-10380 Stockholm 7
Tel: (08) 248340
TELEX: 10547

SWITZERLAND
Industrade AG
Gemsenstrasse 2
Postcheck 80 - 21190
CH-8021 Zurich
Tel: (01) 60 22 30
TELEX: 56788

UNITED KINGDOM
Rapid Recall, Ltd.
11-15 Betterton Street
Drury Lane
London WC2H 9BS
Tel: (01) 379-6741
TELEX: 28752

G.E.C. Semiconductors Ltd.
East Lane
Wembley HA9 7PP
Middlesex
Tel: (01) 904-9303
TELEX: 923429

Jermyn Industries
Vestry Estate
Sevenoaks, Kent.
Tel: (0732) 51174
TELEX: 95143

Printed in U.S.A./A-69-1176/5K

*Field Application Location